The advantages of 3D Printing

Written by Ben Redwood

This article discusses the main advantages of 3D printing when compared to traditional manufacturing techniques.

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Introduction

3D printing creates solid parts by building up objects one layer at a time. Producing parts via this method offers many advantages over traditional manufacturing techniques. While there are a large range of different 3D printing technologies the advantages discussed in this article generally apply to the industry as a whole.

3D printing is unlikely to replace many traditional manufacturing methods yet there are many applications where a 3D printer is able to deliver a design quickly, with high accuracy from a functional material. Understanding the advantages of 3D printing allows designers to make better decisions when selecting a manufacturing technique that results delivery of the optimal product.

Speed

One of the main advantages of additive manufacture is the speed at which parts can be produced compared to traditional manufacturing methods. Complex designs can be uploaded from a CAD model and printed in a few hours. The advantage of this is the rapid verification and development of design ideas.

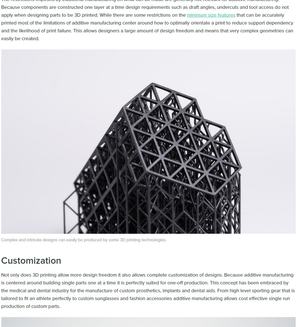
Where in the past it may have taken days or even weeks to receive a prototype, additive manufacturing places a model in the hands of the designer within a few hours. While the more industrial additive manufacturing machines take longer to print and process a part, the ability to produce functional end parts at low to mid volumes offers a huge time saving advantage when compared to traditional manufacturing techniques (often the lead time on a injection molding die alone can be weeks).

A custom functional bracket 3D printed with SLS nylon

Single step manufacture

One of the biggest concerns for a designer is how to manufacture a part as efficiently as possible. Most parts require a large number of manufacturing steps to produce and the order the steps occur in affects the quality and manufacturability of the design.

Consider a custom steel bracket that is made via traditional manufacturing methods. Like additive manufacturing the process begins with a CAD model. Once the design is finalized fabrication begins with the steel being cut to length. The cut lengths are then clamped into position and welded one at a time to form the bracket. Sometimes a jig will need to be made up to ensure all components are correctly aligned. The welds are then ground to give a good surface finish. Next holes are drilled so the bracket can be mounted to the wall. Finally the bracket is sand blasted, primed and painted to improve its appearance.



Additive manufacturing machines complete a build in one step with no interaction required during the build phase. For additive manufacturing as soon as the CAD design is finalized it can be uploaded to the printer and printed in one step in a couple of hours.

The ability to produce a part in one step greatly reduces the dependence on different manufacturing streams (machining, welding, painting) and gives the designer greater control over the final product.

The 3D printing process (red) compared to the traditional manufacturing process (black).

Cost

The cost of manufacture can be broken down into 3 categories; machine operation costs, material cost and labor costs.

Machine operation costs: Most desktop 3D printers use the same amount of power as a laptop computer. More industrial additive manufacturing technologies consume a high amount of energy to produce a single part however the ability to produce complex geometries in a single step results in higher efficiency and turnaround. Machine operation costs are typically the lowest contributor to the overall cost of manufacture.

Material costs: The material cost for additive manufacturing varies significantly by technology. Desktop FDM printers use filament coils that cost around $25 per kg while SLA printing requires resin that retails around $150 per litre. The range of materials available for additive manufacturing make quantifying a comparison with traditional manufacturing difficult. Nylon powder used in SLS costs around $70 per kg while comparable nylon pellets used in injection molding can be purchased for as little as $2 - $5 per kg. Material costs are the biggest contributor to the cost of a part made via additive manufacturing.

Labor costs: One of the main advantages of 3D printing is the the cost of labor. Post processing aside, the majority of 3D printers only require an operator to press a button. The machine then follows a completely automated process to produce the part. Compared to traditional manufacturing where highly skilled machinists and operators are typically required, the labor costs for a 3D printer are almost zero.

Additive manufacturing at low volumes is very cost competitive compared to traditional manufacturing. For the production of prototypes that verify form and fit, it is significantly cheaper than other alternative manufacturing methods (injection molding) and is often competitive for manufacturing one off functional parts. Traditional manufacturing techniques become more cost effective as volumes begin to increase and the high setup costs are justified by the large volumes of productions.

Risk mitigation

An order of a prototype that is faulty costs time and money. Even small changes in a mold or fabrication can have a large impact on cost. Being able to verify a design by printing a production-ready prototype before investing in expensive manufacturing equipment (molds or tooling and jigs) takes the risk out of the prototyping process. This builds confidence before making the large investments required at the mass production level.

Complexity and design freedom

The restrictions imposed by traditional manufacturing on what can be made are generally not relevant for additive manufacturing. Because components are constructed one layer at a time design requirements such as draft angles, undercuts and tool access do not apply when designing parts to be 3D printed. While there are some restrictions on the minimum size features that can be accurately printed most of the limitations of additive manufacturing center around how to optimally orientate a print to reduce support dependency and the likelihood of print failure. This allows designers a large amount of design freedom and means that very complex geometries can easily be created.

Complex and intricate designs can easily be produced by some 3D printing technologies.

Customization

Not only does 3D printing allow more design freedom it also allows complete customization of designs. Because additive manufacturing is centered around building single parts one at a time it is perfectly suited for one-off production. This concept has been embraced by the medical and dental industry for the manufacture of custom prosthetics, implants and dental aids. From high level sporting gear that is tailored to fit an athlete perfectly to custom sunglasses and fashion accessories additive manufacturing allows cost effective single run production of custom parts.

Customizable 3D printed headphones designed by Print+

Ease of access

While additive manufacturing has been around for more than 30 years the majority of growth has occurred in the last 5 years. This has lead to a large number of 3D printers entering the industry making it significantly easier for designers to access additive manufacturing technology. In 2015 alone more than 278,000 additive manufacturing printers valued under $5000 were sold globally with the number of printers sold doubling consistently for the last 3 years. What was originally a niche technology accessible only to a small segment of the manufacturing industry is now a readily available and cost competitive method of part production utilized in a vast range of industries.

Number of printers under $5000 sold globally per year - Wohlers report 2015

Sustainability

Subtractive manufacturing methods such as CNC milling or turning remove a significant amount of material from an initial block resulting in high volumes of waste material. Additive manufacturing methods generally only use the material needed to build a part. Most processes use materials that can be reused for more than one build resulting in additive manufacturing process producing very little waste.

Freiphone 3D printed accessories that are made on demand from recycled wood fiber material

The increase in number of additive manufacturing machines in the world has also impacted the distance prototypes are shipped. Because 3D printers require a very basic understanding to operate successfully, designs do not need to be sent away for expert manufacture. The reduction in shipping requirements has a positive environmental impact. This coupled with the ability to print and produce spare parts on site results in a much smaller carbon footprint for most parts produced via additive manufacturing.

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